Camouflaged Object Recognition

For more information contact **Chi Yung Fu**
(925) 423-1175, fu1@llnl.gov

We have refined and furthered our analysis of the brainwave data obtained from our collaborator at the Biomagnetic Imaging Laboratory at the University of California, San Francisco (UCSF). We achieved 100-fold improvement in time resolution using a novel combination of wavelets and neural networks to extract signals of the brainwaves obtained from magnetoencephalography (MEG). These improvements provided technical results that will enable us to pursue the next phase of camouflaged object recognition.

Project Goals

The goal of the project is to extend our work done in the signal processing area to demonstrate improved signal extraction from extremely noisy brainwave data. The results will enable us to continue this novel technology of using brainwave monitoring to assist intelligence analysts and radiologists in finding "camouflaged," or subtle, objects and to improve human pattern recognition. Figure 1 shows how the traditional approach loses time resolution due to averaging of the MEG data from repeated stimulation. Our approach successfully extracted the brain signal epoch-by-epoch for each stimulation.

Relevance to LLNL Mission

This project is relevant to all Laboratory programs requiring pattern recognition. The most noticeable area is to assist analysts in the intelligence area. This is especially significant after September 11, 2001. Our results can have significant impact on homeland security, NAI, and the Department of Energy and Environment.

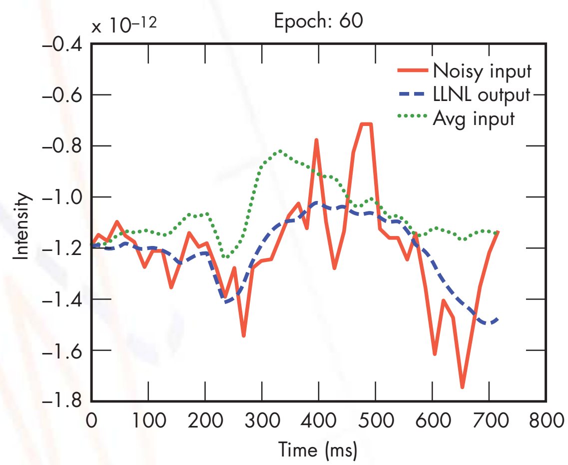

Figure 1. Comparison of results from various approaches to MEG data.

FY2004 Accomplishments and Results

Up to 272 superconducting quantum interference devices (SQUIDs) were used to monitor the MEG brainwaves from the entire scalp. Different devices are activated differently, due to the differences in the responses from the various locations of the brain.

Each waveform from each SQUID consists broadly of two types of responses: one when stimulation is on, and one when stimulation is off. Both are embedded in a large amount of noise from different sources, making them almost indistinguishable. We assume no prior knowledge when the stimulation is presented. We also do not know what a clean waveform looks like. As a result, the neural network is an unsupervised one.

After wavelet preprocessing, the data were processed by a neural network that consists of two back-propagation networks, to learn the two different types of responses presented in our problem. Another network assigns different parts of the data space to these two networks. This divide-and-conquer technique improved upon our previous attempts. A 100-fold improvement in time resolution has been achieved. An invention disclosure is planned.

Figures 2 and 3 are some examples of our results. The decreasing response at ~250 ms, as a function of epochs from 1 to 120, reveals that the brain was adapting to the repeated stimulation. Such adaptation could not be seen from either the raw or the conventional processed data in Fig. 3.

Analyzing satellite images and reading mammograms are essentially looking for a needle in the haystack, and thus, solving one will greatly facilitate solving the other, since our algorithm is not dependent on a particular application. We plan to continue our collaboration with UCSF's Biomagnetic Imaging Laboratory and with the University of California, Davis, Cancer Institute.

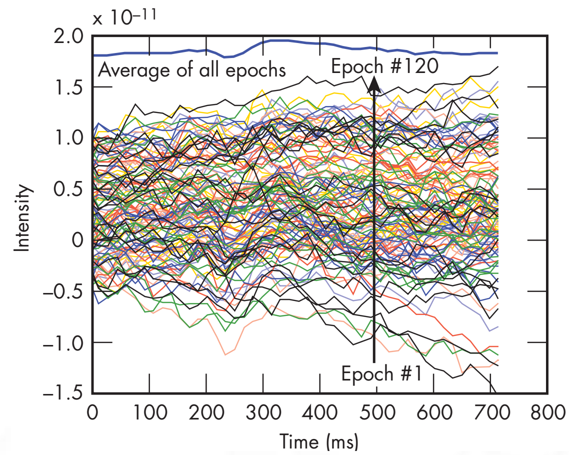

Figure 2. 120 epochs of raw MEG data corresponding to the processed data in Figure 3.

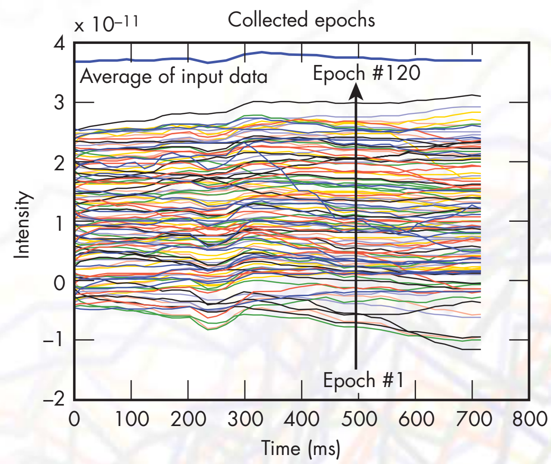

Figure 3. Brain adaptation to the audio stimulation at ~250 ms, apparent using LLNL approach. This allows us to explore the dynamics of the brain.